Chapter 1 <u>Basic MX Concepts</u>

Models, Strings, And Points

The simplest form of data stored within MX is a <u>**point**</u>. Within MX, the point is held as a set of dimensions.

A <u>**string**</u> is a series of points and may be joined by straight or curve-fitted lines. A string of some form represents all surfaces and features. Any line that can be drawn on paper in either horizontal or vertical representation is a string.

A <u>**model**</u> is a group of strings defining a surface. Models can record different types of information, such as a ground surface, a series of features, a network of data, or just points. Each model can then be graphically displayed.

Within MX there are numerous types of strings that may contain between 2 to 15 different types of information. A dimension represents the information.

Ref.	String Type	Dimensions
2D	Contours	X, Y (The elevation is stored with the string header)
3D	General features	X, Y, Z
3D	Point	X, Y, Z
4D	Survey control	X, Y, Z, station name
4D	Text	X, Y, character height, text bearing
5D	Interface	X, Y, Z, offset, bearing normal to point
5D	Profile	X, Y, Z, offset, interpolation method
5D	Cross section	X, Y, Z, offset, interpolation method
6D	Master alignment	X, Y, Z, station, tangential bearing, radius
12D	Geometry string	X, Y, Z, station, tangential bearing, radius, grade, curve parameter, H code, V code, H elem, V elem

Volume Strings

6D	Simple Volume	X, Y, Z, station, cut volume, fill volume
10D	Project Volume	X, Y, Z, station, fill, cut1, cut2, cut3, cut4, cut5
10D	Mass ordinate	X, Y, Z, station, mass ordinate, cut1, cut2, cut3, cut4, cut5

Triangulation strings

33D	Triangles	X, Y, Z, etc.

• Strings are made up of points with lines connecting them.
• A point string is a special kind of string that doesn't have lines connecting the points..
• A string may contain gaps, or "discontinuities", which is where two adjacent points are not connected by a line when the string is displayed or drawn.
• Points that have (Z) elevation values of -999.0 are called "null" elevations, meaning they haven't been assigned an elevation.

String Labels

Each MX string is assigned a unique label. All strings must have a four-character alphanumeric label with no spaces. This may appear to be a restriction, but here are over 1.6 million combinations available for each model. MDOT has a Standard Naming Convention for use in determining what string labels are used to describe each survey feature or design element. This *naming convention is described in detail in MX User Note SNC-1* in the appendix.

Labeling Restrictions

- Only master alignment strings may begin with "M"
- Only point strings should begin with "P".
- A special first character of an "*" denotes a text string that is located by field coordinates.
- Geometry strings are special strings containing horizontal and vertical alignment information, and begin with "G".

MX Structure

Each project has its own database for storing information called the model file. From the previous information, you can establish a hierarchy:

```
              |---MODEL 1 --------Strings ---------Points ---------Dimensions----------Digits
              |
Model File ----|---MODEL 2 --------Strings ---------Points ---------Dimensions----------Digits
              |
              |---MODEL 1 --------Strings ---------Points ---------Dimensions----------Digits
```

A project is held in a **model file,** which consists of a set of models; a **model** consists of a set of strings; each **string** consists of a sequence of points; each **point** consists of two or more dimensions; and each **dimension** consists of a sequence of digits.

Command Language

To access and manipulate stored models, use MX's **command language**, a set of one-word commands that control the input, manipulation, and output of sets of data. The data represents strings, points, and ultimately models.

The commands have a two-tier structure of major and minor options in which the majority of major options have a set of minor options nested within them.

Major options set up processes such as generating, editing and updating models, determining areas, and executing highway design functions. The major options reflect their function; for example EDIT, COPY, or REPORT. Each of over 50 major options is independent of all the other major options.

The **minor options** are numeric, three digit numbers in the range 000-999. They operate on strings, performing tasks such as 'Delete a string,' 'Create a section of a string by constant horizontal offset,' and 'Draw a grid.' These tasks are within the range of work encompassed by the major options, which operates on the whole model. Of the over 300 minor options, eight (8) apply to more than one major option. These eight are called **global options**.

Linemode

The various wizards and panels in MX are simply a means to gather input from the user and form commands sent to the main MX Engine. The user can also submit these commands directly to the MX engine either by creating an INPUT file, or typing the individual lines in the LINEMODE window. To access the LINEMODE window:
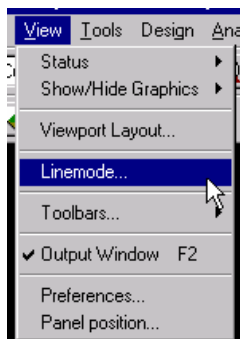
Select *View => Linemode* from the menu bar.

The Linemode window will appear. The line at the bottom is where the MX Command Language lines are typed. Hitting enter after each line is typed will execute the line, and add it to the text area above the input line. You can copy lines from this area to submit them again, or to paste them into an input file. The example Linemode window below shows Major Option REPORT being used to obtain string point information from string POLE in the GROUND Model. Minor Option 999 concludes the use of Major Option REPORT.   Specific information on the command language will be provided later in this manual.
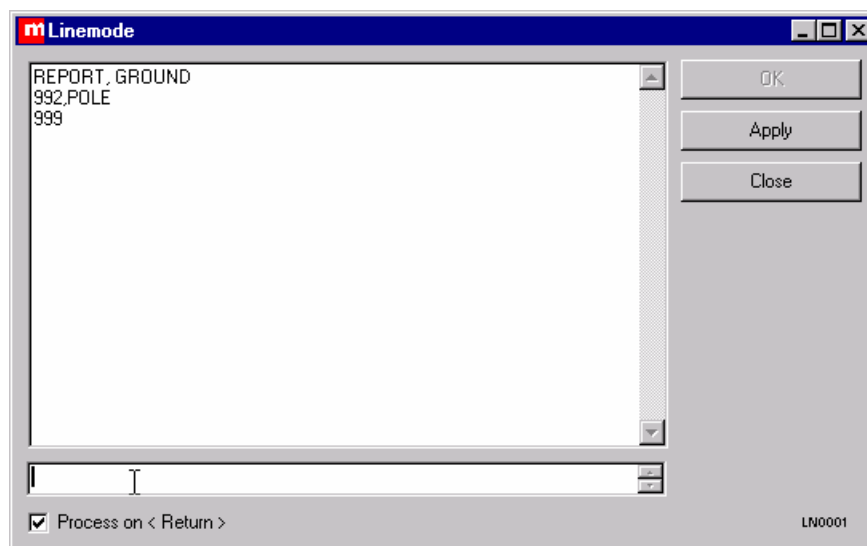
Model Naming Convention

Models within the database must have unique names that are no more than 28 alphanumeric characters including spaces between words.   The name you select should be a meaningful name, not only to yourself but also to anyone else who might continue the project if you leave it. MDOT's Survey Section will create the following models:

TRAVERSE   -   Contains the survey traverse points
GROUND   -   Contains the Existing Ground model
POINTS   -   Contains all survey points picked up in the field (with point numbers)
TEXT   -   Contains the text associated with the Existing Ground model
TRIANGLES   -   Contains the digital terrain model (DTM) or surface used for sectioning
CONTOURS   -   Contains contours interpolated from the TRIANGLES model

To create your proposed design, you'll need to make some new models to contain your data. If you are not considering multiple design alternatives, then you should name this model **DESIGN**. Multiple design alternatives should be kept in separate models. You can differentiate between these alternates by naming models DESIGN1, DESIGN2, DESIGN3...etc.

Section models will be created to contain cross section and profile strings. A separate section model must be created for each alignment in each design alternate, so you should name your section models as follows:

If one design alternate is being considered, for an alignment named "MC10", the section model would be called: **XSMC10.**

If you are considering multiple alternates, than you must further specify which design alternate your master alignment belongs to. Alignment MC10 in DESIGN1 would have a section model named: **XSMC10 DESIGN1**

Drawings Versus Displays

In MX, we can create either Displays or Drawings to show our project data in. The differences between these are:

Displays (*.dpw): Displays are what MX uses to do any sort of design or editing work on. Think of it as the "working display". You can access any of the Design, Modify, or Analysis tools on these displays. You don't plot or mifile DPW's, though the proposed design is sent to MicroStation using a DPW.

Drawings (*.dpf): Drawings are created from Displays when you need plot or MxChange your design drawings. Any model data displayed on a "sheet", with borders, margins, etc. is a DPF. You can't access the Design, Modify, or Analysis tools on these drawings. You can only use the DRAW options to enhance them.

Style and Feature Sets (*.pss, *.fns)

**Style sets** are used to display model data in a predetermined "style", or combination of line styles, weights, colors, and macro symbols. Each model used must have a style set assigned to it. Every time this model is shown in the graphics area, it will be displayed as specified in the style set. For the existing GROUND Model, there is a style set called "MDOT Plan Gray.pss". This style set will display the existing ground model in a color scheme that's predominantly light gray in color, making it easier to see the proposed design on top of it. Likewise, you can also assign "MDOT Plan Color.pss" to this model to display the existing ground model in a more colorful scheme, where similar features are displayed in the same color, but multiple colors are used to display different types of elements.

Feature Sets are likewise associated with each model, and provide an association between the String Label Convention, and a description of a given highway or topo feature. These sets are used in the MX routine to help automate the assignment of string labels for design strings.

More detailed descriptions of these files will be provided later in case you want to develop some of your own, but MDOT standard sets will be provided for the commonly used Model Names.

MODEL	STYLE SET	FEATURE SET
GROUND	MDOT Plan Gray.pss	MDOT Plan Gray.fns
TRIANGLES	MDOT Triangulation.pts	MDOT Triangulation.fns
CONTOURS	MDOT Contours.pss	MDOT Contours.fns
TEXT	MDOT Text Strings.pss	MDOT Text Strings.fns
DESIGN	MxRoad.pss	MxRoad.fns
XS*	MDOT Cross Section.pss	MDOT Cross Section.fns

NOTE: In order to use the full functionality of the MX Software, your proposed design model must use the MxRoad style and feature sets.

Starting The Software:

The MX Software can be started by double-clicking on the shortcut provided on your Windows XP desktop, or by selecting Start, then Programs, then *MX in Windows V2*, then *MX Professional in Windows V2* from the task bar. The software will execute, and either provides you a startup panel with the new logo on it, or an empty window with "File" and "Help" on it.
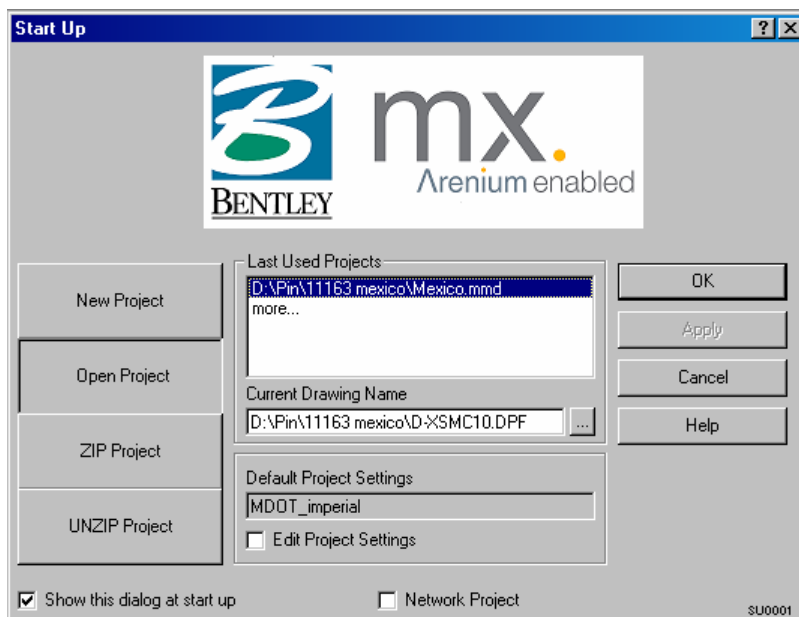

Assuming you receive a startup panel, the bottom half of this panel should look something like this:

1. Select the **Open Project** Button.

2. Either Select one of the **"Last Used Projects"** by double-clicking on it, or double-click on the more... in the Last Used Projects frame. If you select the **"more..."** button, you'll see a standard **"open Project"** dialog box like the one following:

3. Browse to your local project file (This is usually located at **D:\pin\#####.##\project.MMD**) and select the project.mmd. Then click on the **Open** button. The *.mmd file is the MX Project file. To edit the settings contained in a project file before starting MX, check the **"Edit Project Settings"** check box before proceeding, or from the front startup panel before proceeding to the next step.

If you'd like to have this startup panel each time you enter MX, then leave the **"Show this dialog at start up"** check box checked. If you'd rather skip this panel, then uncheck this box. *(NOTE: The Network Project box should be left unchecked.)*
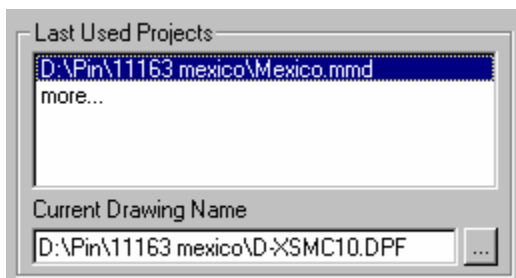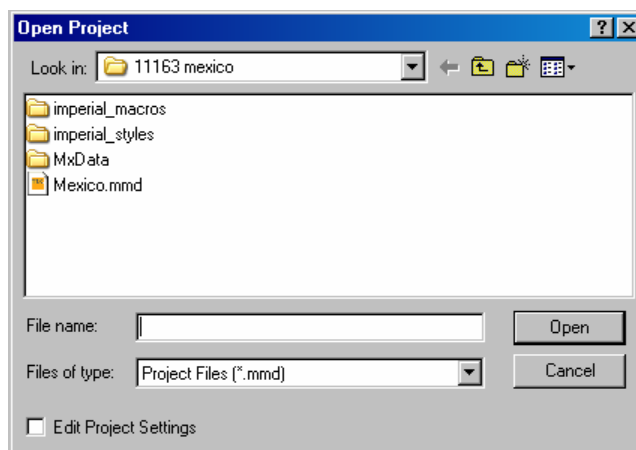
Below the "*Last Used Projects*" dialogue box is the **"Current Drawing Name".** The directory path of this drawing should match the project location where you are working. This also allows the user to select which drawing that Mx will start in at the project level.

The dialogue box below the "Current Drawing Name" is very important to the proper function of the Mx design features. The **"Default Project Settings"** box allows you to select whether the project is U.S. Customary or Metric. If you are working on an existing project be sure the correct units are being displayed.
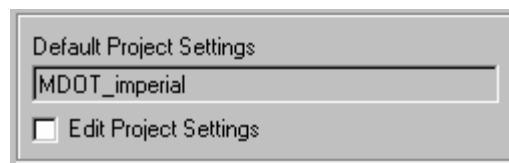
You should now have the MX software running, either by clicking on the last-used project path, or by selecting the project through steps 2 and 3 using "more..." above.

The Graphical User Interface (GUI):

Once you've started the software for the first time for a particular project, it will open with a blank display called "draw.dpw", just as classic MOSS did. The next time you start MX for that project, it will remember the last-used drawing/display, and open that automatically.
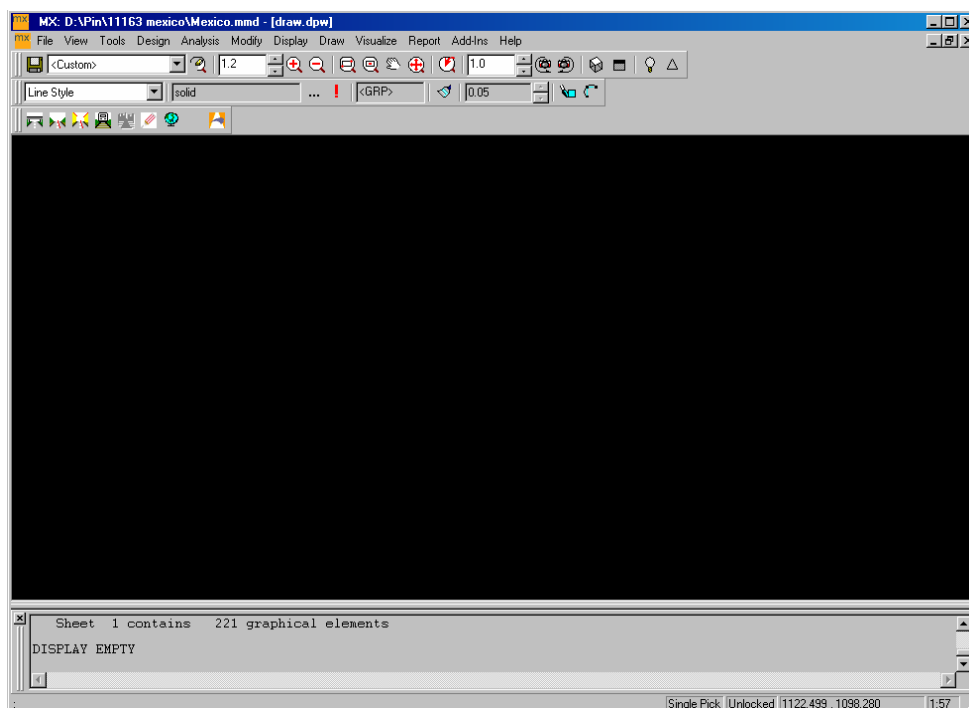
Here's the basic MX Screen:

1. The Title Bar
2. The Menu Area
3. Zoom Toolbar
4. Style Toolbar
5. Applications bar

6. The Graphics
   Window

7. The Output Window

8. The Status Bar

The numbered areas are:

1. The Title Bar: This displays the path to the current project file, as well as the currently open display or drawing name.

2. The Menu Area: This is the main menu to access the MX options. Each Menu will be discussed in detail later.

3. The Zoom Toolbar: This toolbar controls all of the zooming or windowing to be performed on the graphics window. It will be discussed in detail later.

4. The Style Toolbar: This toolbar allows the user to change various display options such as line (style, color, width); text (style, color, width). These options can be applied by single feature, groups, or complete models.

5. The Applications Toolbar: This toolbar may or may not be on you display. It contains the Mx components of MXROAD, MXRENEW, MXURBAN, MXRAIL, MXSITE, MXDRAW Manager. It is not something that MDOT uses often.

6. The Graphics Window: This is where the MX data is drawn.

7. The Output Window: When options are being run in MX, the resulting output is scrolled in this area, just as it did in the Alpha Window in Classic MOSS. The only difference is that you don't type anything into this area.

8. The Status Bar: This area shows you the current mode being used for selecting graphics, the current screen coordinates, and time of day. When MX is processing data, a graduated bar is also displayed on the left hand side, showing approximately how far along in the process MX is. It also shows help messages as you work through options and menus.

Procedures Manual

mdot **mx**

The Zoom Toolbar:

Located below the menu area, the zoom toolbar icons are as follows:
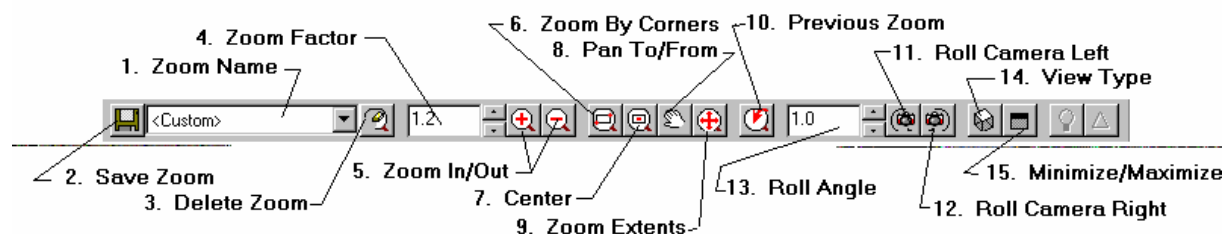
The different areas of the toolbar are:

1. Zoom Name: This drop-down box contains the names of saved zooms, which you've created for working on your drawing or display. It remembers not only the size of the window you've created, but also how it was rotated. It's very handy for quickly moving to intersection areas, or other areas of importance.

2. Save Zoom: This icon saves the current zoom in the graphics window. A box will pop up asking you to provide a name for this saved zoom. It will then appear in the Zoom Name drop-down box.

3. Delete Zoom: Pressing this button will delete a saved zoom

4. Zoom Factor: This box contains a number, which is used to determine the "step" at which the Zoom In/Out buttons function. Larger numbers provide "faster" zoom action. You can type in a factor by first clicking in the textbox, or use the spinner buttons to increase the value up or down.

5. Zoom In/Out: These buttons dynamically zoom in or out on the centermost point of the graphics window, depending on which you click on. If you click and hold on these buttons, they'll continuously zoom.

6. Zoom By Corners: Click this button to window in on the graphics display by specifying two points representing two opposite corners of the desired view. This is the same way we did it in Classic MOSS.

7. Center Window: This allows you to dynamically choose the center of your display by clicking on a point on the graphics area. This button is a "sticky" button. Make sure you turn it off by clicking on it again before you move on to do something else.

8. Pan From/To: This button allows you to move your graphics area in any direction by first selecting a point from the screen, then selecting another point from the screen where you want the first point to move to.

9. Zoom Extents: This button will return to the original plan display, un-rotated, and un-zoomed.

10. Previous Zoom: Clicking this will return you to the last zoom or window. It's kind of like an "undo" button if you zoom incorrectly.

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11. Roll Camera Left: Clicking this button and holding it, will dynamically rotate the display area in a counter-clockwise direction at the rate specified by the rotation angle.

12. Roll Camera Right: Clicking this button and holding it will dynamically rotate the display area in a clockwise direction at the rate specified by the rotation angle.

13. Roll Angle: This box contains a number, which represents the angle used as a "step" when using dynamically rotating the view. Larger numbers provide "faster" rotation. The values are changed in the same way as the Zoom Factor.

14. View Type: Clicking this icon will provide a drop-down box which contains other icons allowing you to switch between top view, and 4 different isometric views of your model information.

15. Minimize/Maximize: If you currently have multiple view ports on the screen, this button will allow you to quickly make your current view port the only one visible, taking up the entire graphics display. Clicking it again will return to the multiple view port setting.

The Menu Bar

The Menu Area is where you access the "guts" of the MX software. It looks like this:

1. File: This menu allows you open new or existing displays and drawings, plot drawings, import or export drawing information to other formats, produce journal and output files, and run input files. It also provides access to some new features such as MOSS Explorer, and the String name Converter. Plotting from MX is also accomplished through this menu. UPM is also located here, but you can only run LINEMODE UPMs.

2. View: This menu allows you to hide/delete graphics from your current display or drawing, access Linemode, Set software Preferences, and determine what Toolbars are present

3. Tools: Custom line styles, text styles, and macro symbols can be created from this menu. It also allows you to access the system parameters, and assign default style and feature sets to each model. Mask Tables are also created through this menu.

4. Design: All of the options available under Major Option DESIGN are found here, as well as any other tools, which are used to create your proposed roadway design. The MXRoads design functionality is built into these menus as well.

5. Analysis: This menu contains tools to create Triangulations, Sections, Contours, and to determine areas and volumes.

6. Modify: This menu contains the tools necessary to alter models, strings, and points. It contains the Major Option EDIT commands, as well as Major Option COPY commands. It also provides access to the Cross-section editor.

7. Display: This menu provides the tools to display model information on the display window.

8. Draw: All of the tools to create drawings for plotting or export are located here.

9. *Visualize:* A set of tools to create perspective views and drive-through animations.

10. *Report:* Access to Major Option REPORT, with some nice new reporting tools.

11. *Add-Ins:* This menu allows you to provide a link to custom applications or other programs, which you want to execute from within MX. The MDOT Driveway Design Program, as well as some new ones will be accessed here.

12. *Help:* Access to the MX online Help.

Journal Files

When you use the various MX panels to create/edit strings and models, command language lines are sent to the MX engine. These commands can be recorded into a journal file which can be used to build INPUT files for later use should you need to restore your design at some point and don't want to redo all of the wizards. To start recording a journal file:
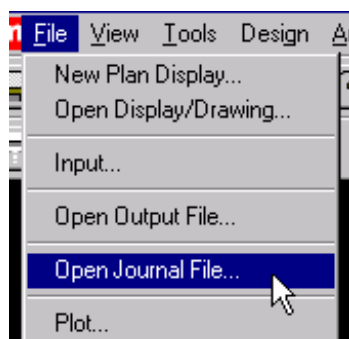
1. Select ***File => Open Journal File*** from the menu bar.

2. You are prompted to provide a file name for this journal file. Type a meaningful name for the activity you are about to perform, then click OK to open the file. (example: MakeRoadTemplate.jou)

3. You are shown a message box indicating the successful opening of the requested file, or presented the options of overwriting or appending a file if the named file already exists.

4. Next you must specify a Journal Recording Method on the following panel:

The descriptions on the panel are pretty self-explanatory. Most often, you'll want to Record and Rationalize the commands.

Click **OK** after selecting the method.
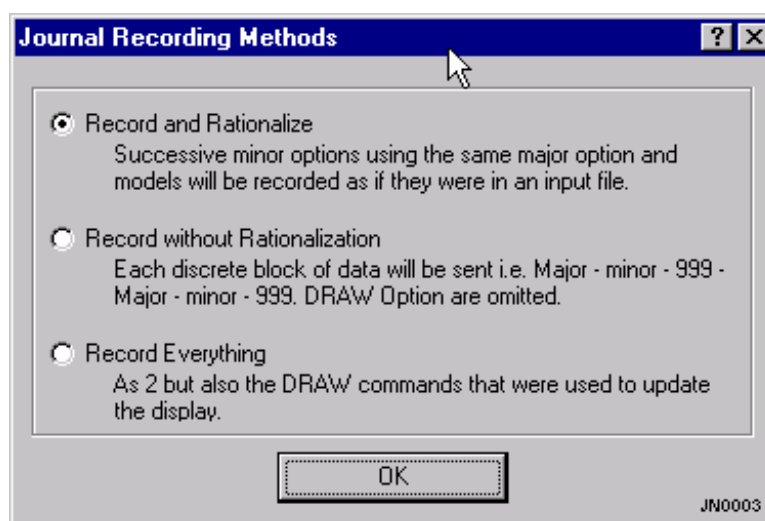
5. A small toolbar will appear, which functions like the buttons on a tape recorder:

 From left to right, the buttons are **Record**, **Pause**, **Stop**, and **Add Comment**.

This toolbar allows you substantial control over what's recorded, and you can add in comment lines to indicate the activity being performed which will make it easier to decipher your journal file at a later date.

6. To close the Journal File, click the stop button.

The contents of a journal file look something like this:

```
JOURNAL OPENED AT  17 02 2000  12-22



EDIT,GROUND
008,3=WP01,5=862729.07445431,6=236276.57357788,7=-999.
008,3=WP01,5=862735.55895805,6=236302.79420471,7=-999.
999


JOURNAL CLOSED AT  17 02 2000  12-24
```

In this example, a string called "WP01" was created in a model called "GROUND", and was made up of two points, which are defined by the "008" command lines.

Output Files

An output file is created in a similar manner to a journal file, but rather than recording the actual MX commands, it records the resulting data generated from an activity. For example, if we were to create a report on a string's points, we could direct the resulting point information to be written into a file, rather than (or in addition) to the output window on the MX User Interface.

Here are the steps to do this:
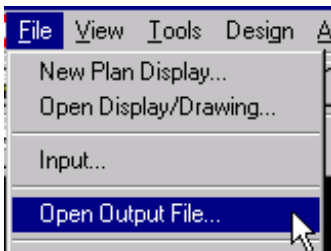
 1. Select **File => Open Output File** from the menu bar.
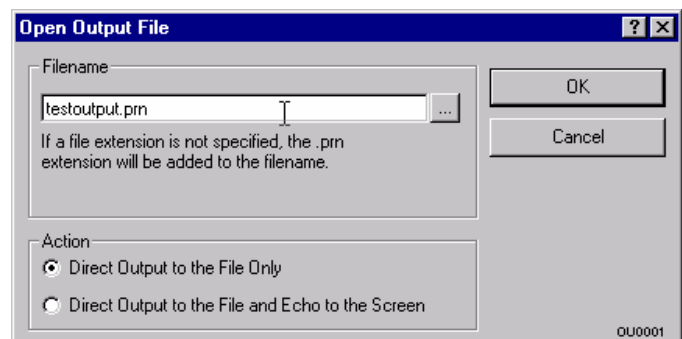
2. Type in a suitable filename to describe the data that will be sent to the file, and

select whether you want to direct the output only to the file, or to both the file, and the screen, then click OK.

3. You should now see the Output toolbar, which looks and functions almost identically to the Journal toolbar. The major difference is that you cannot add comments from this toolbar.

Now that the file is open, any MX operations that produce data output will send that output to the file you specified. To illustrate this, let's do a report on the string points of string POLS in our existing GROUND Model.
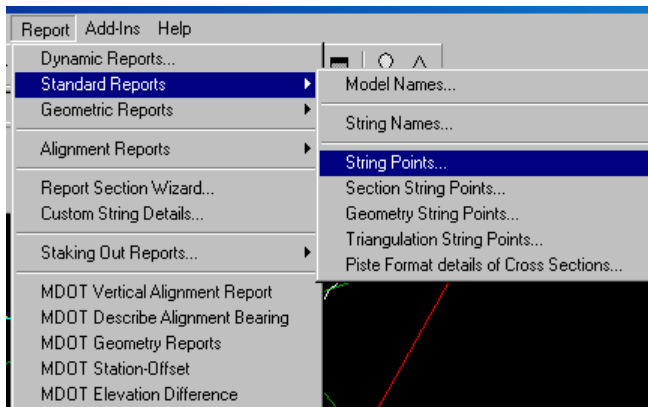
4. Select **Reports = > Standard Reports => String Points** from the menu bar.
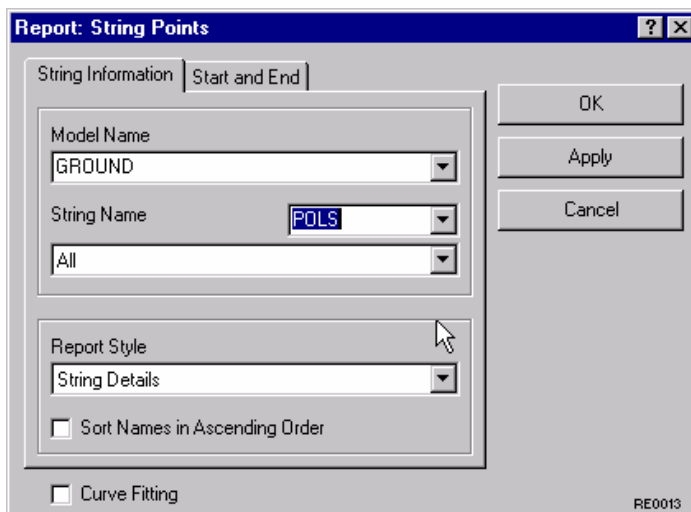
5. The Report: String Points panel will appear. Select the model name (GROUND) from the Model Name drop down box, then the string label (POLS) from the String Name drop down box. Also check to see that String Details is selected under the Report Style heading at the bottom of the panel.

Click **OK** to create the report, and send the output to the file.

6. Click **Stop** on the Output Toolbar to close the file and dismiss the toolbar. The resulting file contains information as shown below:

```
992POLS

NAME   SUBREF   CONTENTS NO.PTS   X -MIN  Y -MIN  X -MAX  Y -MAX RECORD LOC.

POLS        100007703     2    862718  235594  862827  236450   927 131

POINT   -----X----- -----Y------ ----Z-----

   1   862826.523  235594.432    522.268
   2   862718.369  236449.302    488.357

999

END OF REPORT----------------------------------------------------------------------

OUTPUT
```

Compressing The Model File

The standard model file can contain 50,000 records. As models, strings, and points are created, deleted, or modified, the available space for data in the model file (i.e. records) is used up. To keep MX running efficiently, it becomes necessary to reclaim some of these records. This is done through a process called _compressing the model file_. Model files should ideally be compressed at the end of each day that a project is worked on, but as a minimum, compress those model files that have been worked in weekly. To compress a model file:

1. **Select File => File Management => Compress** from the menu bar. A panel will appear providing a warning that data can be lost, and requiring you to select either Model File, or the current Display/Drawing File to compress.
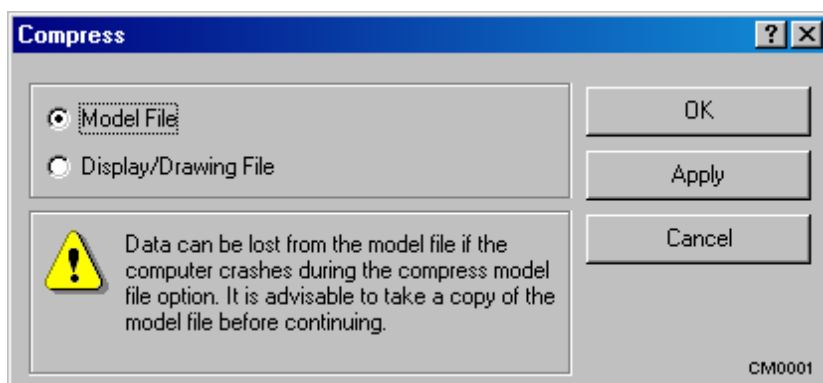
2. Select **Model File** from the panel, then click **OK**. You'll receive a notice when done.